

Radiation MHD Modeling of a Proposed PBFA Dynamic Hohlraum

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We have performed 2D radiation magnetohydrodynamic simulations of a dynamic hohlraum target designed to be driven by the PBFA accelerator at Sandia National Laboratory, Albuquerque, NM. The dynamic hohlraum concept employs a high Z, JxB-imploded, plasma shell as the hohlraum wall. Stagnation of the shell against lower Z material inside the shell causes conversion of kinetic energy to thermal energy and soft x-rays. The concept modeled here employs a 2.4 cm diameter, 2 cm long, tungsten wire array of mass 9.06×10^{-3} g/cm as the high Z shell material. The wire array implodes on low density foam with an annular, hollow cylinder of lithium hydride occupying the central region. To reduce the level of magneto-Rayleigh Taylor (RT) instability, the foam is divided into two portions of different density. From a radius of 0.5 cm to 1.0 cm the foam consists of SiO₂ at a density of 2×10^{-3} g/cc. CH foam at a density of 5×10^{-3} fills the space between radii of 0.266 cm and 0.5 cm. The LiH cylinder is 60 μ m in thickness with a density of 0.84 g/cc. The foam/LiH density profile roughly approximates the tailored density profiles found to reduce RT instability in earlier simulations. 1D simulations show the stagnation of the LiH cylinder at a minimum diameter of about 0.2 cm, with a peak temperature in the LiH of 230 eV and temperatures exceeding 200 eV for 7.7 ns. The peak temperature occurs 55 ns after the current peaks at 18 MA, which is 157 ns after the beginning of the current rise. The Rosseland mean free path in the LiH exceeds 1 cm, allowing unimpeded flow of radiation axially from the dynamic hohlraum to an adjacent target. The LiH completely fills the hohlraum at a density of order 0.3 g/cc and pressure of order 60 MB. Coarsely-zoned 2D simulations (not accounting for RT modes) indicate an effective drive temperature of 180 eV into a perfectly-absorbing load located at one end of the hohlraum. A partially reflecting load would be driven at temperatures between 180-230 eV. Finely-zoned calculations including the effect of RT modes have also been carried out. Single mode calculations with 1% density perturbation and a 2mm wavelength show significant instability growth in the tungsten, but little perturbation of the inner layers. At stagnation against the LiH annulus, the bubble-spike formation in the tungsten is partially reversed. The peak temperature in the 2D case is lower by 13 eV, and the LiH remains optically thin at about the same diameter as the 1D simulation. 2D multimode simulations with 5% initial random density perturbation are in progress, showing mode growth in the tungsten and relatively small perturbation of the inner layers as in the single mode case. The RT calculations do not include the effect of an x-ray-absorbing load.

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